Laser Additive Manufacturing

Solution Guide

CAMBRIDGE TECHNOLOGY
A Novanta Company

Also known as 3D printing, additive manufacturing is the process of joining materials to make objects from a 3D model by adding layer by layer from the bottom up. Advances in digital technology have enabled additive manufacturing to revolutionize industrial production by incorporating fast, precise methods to create fully unique three-dimensional objects.

Types of Laser Additive Manufacturing Processes

Based on the technology used, there are different types of additive manufacturing processes. Here, we will discuss Laser Additive Manufacturing (LAM) which uses a laser as the heat source to build 3D objects. This refers to the process of using a laser as the heat source to build 3D objects layer by layer. Depending on the material and process used, LAM technologies are further categorized into three categories: **Stereolithography (SLA), Selective Laser Sintering (SLS) and Selective Laser Melting (SLM)**. SLA uses UV laser sources to solidify photo-reactive resins layer by layer with fine details. SLS uses CO_2 lasers to sinter polymers such as polyamides that are in the form of powder. In the case of SLM, layers of fine metal power are melted together to form the final structure by fiber lasers.

In all three LAM processes, the laser beam is steered by a laser beam scanner at high speed to the target locations on the build plane defined by the 3D model. The scan controller and software convert the 3D model job into a series of motion and laser control commands to synchronize laser beam scanner motion and laser firing. Reducing the cost of part built and improving the part quality have been two key challenges for expanding LAM applications, particularly SLM. Laser beam steering is critical, and scanner and controller selection impacts those system-level performances directly. For example, how accurately the scanner steers the laser beam to the target location of the build plane determines the part geometric precision. A high-quality part also requires that the uniform laser density is delivered at the materials to ensure homogeneous material properties. This requires precise coordination of the laser firing/modulation and scanner motion. The scanning speed when the laser is on and jumping speed while the laser is off also determine the overall process throughput, thus the cost per part built.

Markets Served

Stereolithography has been used to produce medical models for implants and prototyping parts since the 1990s. The medical models have been used to aid the manufacture of personalized implants. With the capability to build larger 3D parts and quick turnaround, prototyping parts made by SLS process are increasingly used in the design cycle for automotive, aerospace, military and electronics hardware. Those polymer-based 3D parts are sometime also used as final products. In recent years, Selective Laser Melting has shown the most rapid growth as it builds functional parts that go into implants, dental, automobile and aerospace. SLM technology has demonstrated the capabilities to build complex geometries and light-weight structures that are difficult to achieve with conventional subtractive manufacturing methods. It is also flexible and cost-effective when building custom parts such as individual dental parts.

Technology

There are many galvanometer-based laser beam scanner products on the market today. Each configuration has benefits and limitations depending on the LAM system level requirements and the priority of those requirements. The typical factors under considerations when choosing a scanner include:

- Laser source
- Feature size or beam size
- Build rate or scanning speed
- Position accuracy
- Stability
- Build size or envelop
- Ease of integration
- Budget

SLA, SLS and SLM use different types of laser and laser power and require different beam size on the build plane. The scanning mirrors and coatings need to be tailored to accommodate the difference. And the physical size of the finished part, build rate and minimal feature size often dictates the complexity of the laser scanning system and its integration.

More details can be found in Xi Luo, Jin Li, and Mark Lucas, "Galvanometer scanning technology for laser additive manufacturing", Proc. SPIE 10095, Laser 3D Manufacturing IV, 1009512 (24 February 2017).

Cambridge Technology's Solutions for LAM

Cambridge Technology offers a wide range of scanning products that system integrators can choose from based on the trade-offs of various requirements. For example, a desktop system may be best served by an 83xxK series XY galvo set mounted on a small block and driven by a low-noise analog server for a very compact scanning footprint. Also available is an easy-to-use DC series digital server. Conversely, a machine producing large, high-quality metal parts may require multiple 3-axis full-digital scan heads for high accuracy and stability. In addition to the various options of XY scanning sets and scan heads, intelligent scanning control offered by our ScanMaster Controller (SMC) orchestrates laser lasing with scanning motion, further improving accuracy, processing flexibility, and throughput.

Benefits

Among various scanning configurations Cambridge Technology provides, Lightning™ II full-digital scan heads and intelligent ScanMaster Controller and Software which excels at achieving high quality parts with maximal throughput. Lightning™ II features a digital encoder with 24-bit resolution and advanced digital servo model that ensures a scanning accuracy of 10µm or better. It also gets to a jump speed of up to 50 rad-optical/sec with 30mm aperture mirrors, thanks to the ingenuity in the design of our lightweight mirrors and powerful motors. Our SMC controller provides two distinct benefits for laser additive process. First, it offers multiple techniques to maintain uniform laser density at the corners or ends of the hash lines. Secondly, ScanPack, the predictive control algorithms available through SMC controller, optimizes the scanner movement and laser synchronization based on the regional pattern accuracy and speed requirements by adopting adaptive and local trajectory planning. When combined with a Lightning™ II scan head, it offers results in improved overall job throughput.

In addition to the products we offer, one thing that sets Cambridge Technology apart is our team of application engineers working with our customers side-by-side. We have a local presence on a global scale to solve the tough problems and are committed to our customers' success.

Industry's highest-precision scanning speed for maximum throughput

Proprietary technology allows optimized performance in laser scanning control

Increased flexibility by ensuring laser spot remains in focus across working field thanks to Dynamic Focusing Module (DFM)

Tested to perform in laser additive applications delivering high-performance

Global presence and expertise equipped with state-of-the-art application labs and on-site field support

3-Axis Scan Heads

Our 3-axis digital scan head, Lightning™ II is the ideal solution for demanding applications like Laser Additive Manufacturing. Featuring the industry's highest-precision scanning speed for maximum throughput, this solution focuses the laser into a small spot, which improves laser processing speed and quality. The Lightning™ II comes equipped with a Dynamic Focusing Module (DFM) that offers substantial flexibility to system integrators for material processing over large work fields and three-dimensional surfaces. The DFM ensures the laser spot remains in focus across the entire working field. Addionally, the 3-axis scan head can adjust to varying working distances and active field sizes to accommodate different parts to be processed.
Key features include:

- Industry's highest-precision scanning speed for maximum throughput
- Robust, versatile system that easily switches from job to job
- Range of options available for processing specific material-type
- System stability and reliability reduce production downtime
- Increased focus stability for fiber laser applications

Laser Control and Scanning

Cambridge Technology's ScanMaster Controller & Software is designed to synchronize mirror position with laser firing using proprietary ScanPack algorithms or with traditional control schemes. The ScanPack's algorithm optimizes the synchronization process to further increase throughput making it ideal for demanding applications like laser additive manufacturing. When combined with our Lightnining™ II digital scan head, this laser scanning control solution features the industry's highest system throughput, resolution, and accuracy. Some key benefits include:

- Simplified laser integration with plug-and-play laser adaptors
- Unmatched positioning accuracy enabled by the industry's highest 24bit GSBus command resolution
- Uniform laser power density and higher throughput empowered by our proprietary ScanPack algorithm
- Optimized laser processing with our adaptive wobble trajectory capability
- Flexible system integration and easy job creation driven by powerful object oriented ScanMaster API
- Standalone operation built in

Interested in speaking to one of our knowledgable representatives?

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